



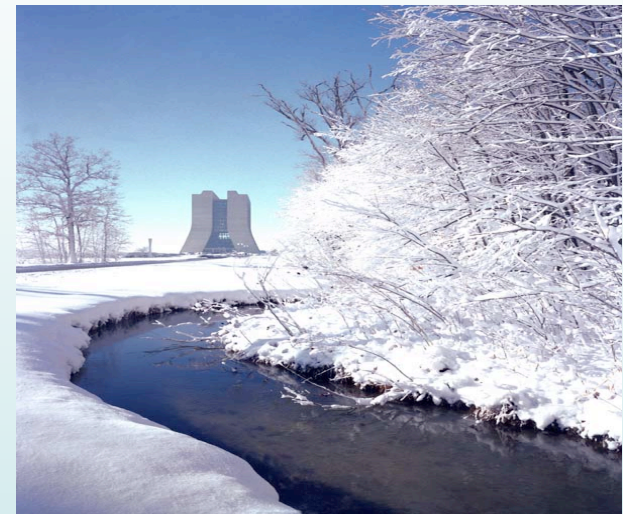
Latest jet results from Tevatron



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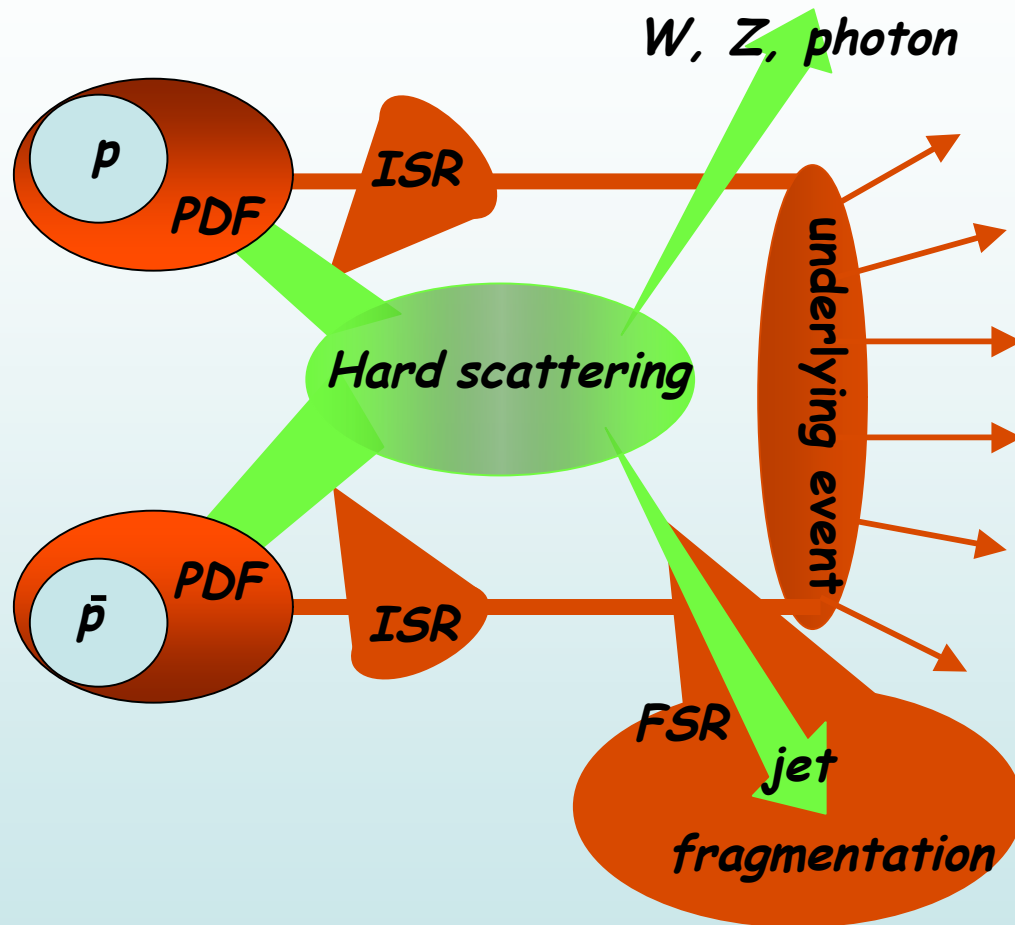


On behalf of CDF & D0 collaborations

**XLI Rencontres de Moriond
QCD and High Energy hadronic Interactions
La Thuile - Italy, 18-24 March 2006**



Jet Physics at 2TeV



Outline

Jet algorithms
Low P_T QCD

This is only a selection
of latest jet results
from Tevatron!!!

- Correlation of particle inside a jet & Fragmentation

High P_T QCD

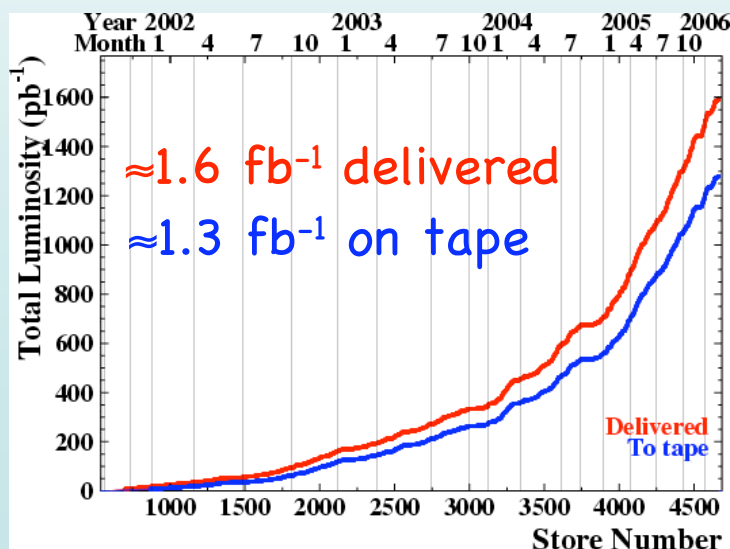
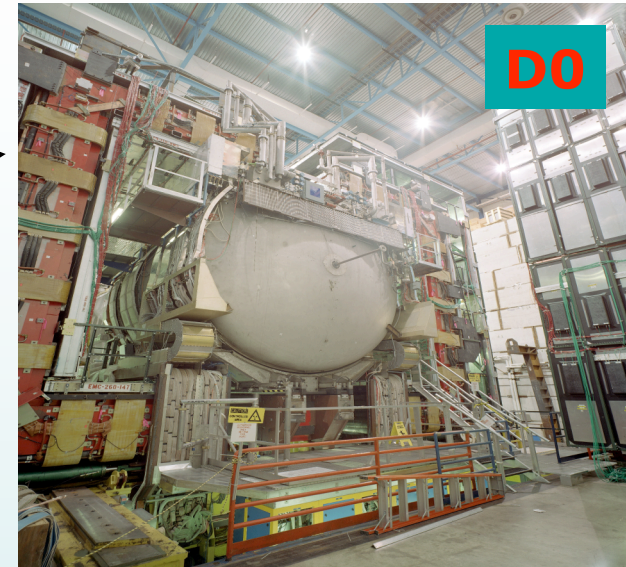
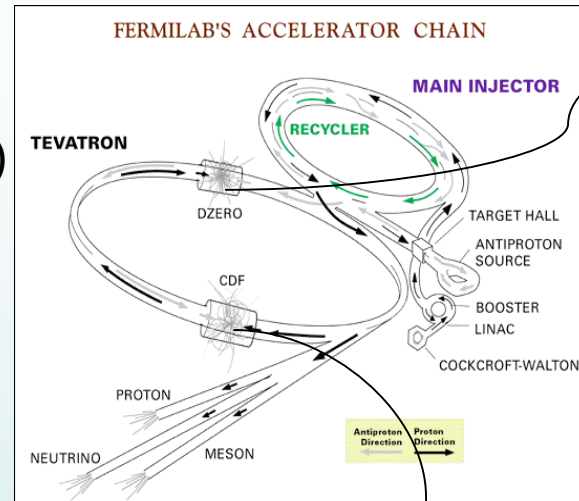
- Inclusive jet cross section:
 - ✓ Midpoint (cone) and K_T central jets
 - ✓ k_T forward jet
- Heavy flavour jets:
 - ✓ μ -tagged jet cross section
 - ✓ b -jet cross section



The experimental environment

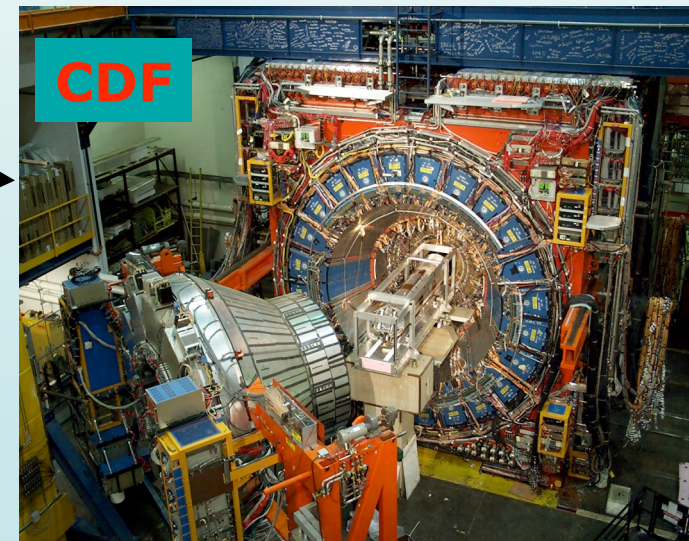


- ✓ p-pbar collisions
- ✓ $\sqrt{s}=1.96$ TeV (RunI 1.8)
- ✓ 36 bunches, 396 ns
- ✓ peak $\text{Lum} \geq 10^{32} [\text{cm}^{-2}\text{s}^{-1}]$
- ✓ $\approx 25 \text{ pb}^{-1}/\text{week}$



Both detectors
performing well

Analyses with
 $0.3\text{--}1.0 \text{ fb}^{-1}$





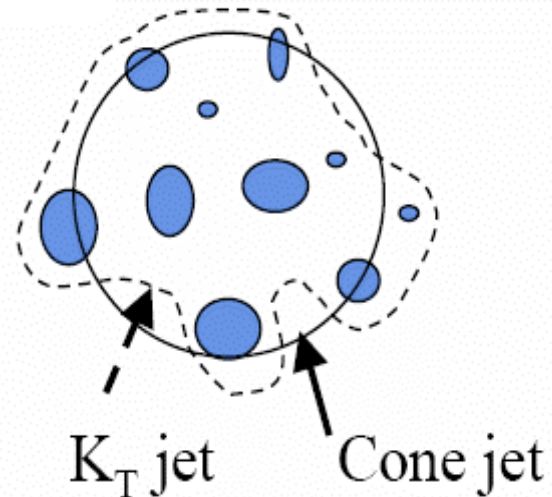
Jet algorithms



Jets are collimated sprays of hadrons originating from the hard scattering

Appropriate jet search algorithms are necessary to define/study hard physics and compare with theory

Different algorithms correspond to different observables and give different results!

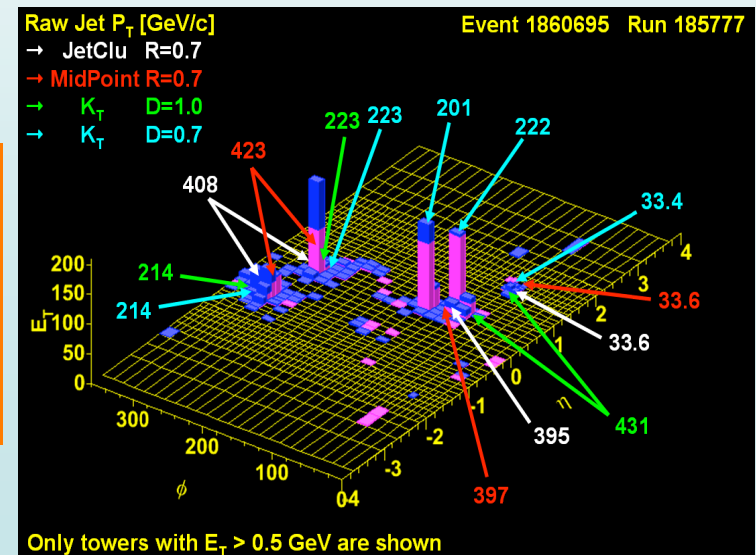


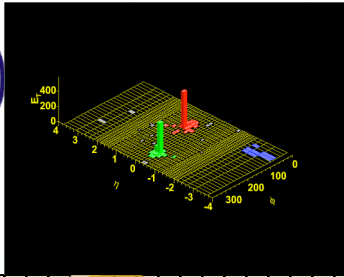
K_T

Cluster particle/towers
Based on their relative p_T
Infrared and coll. safe
No merging/spitting

MidPoint (cone)

Cluster particle/towers
Based on their proximity
in the y - ϕ plane

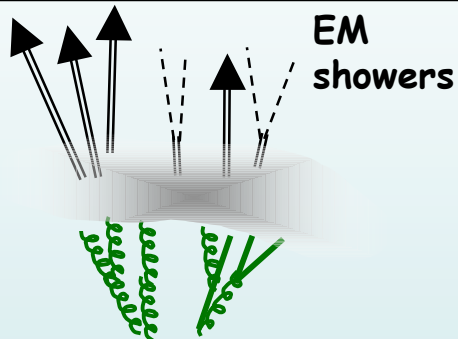




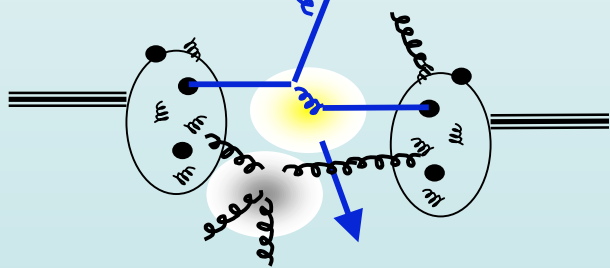
Jet corrections



Hadronic showers



EM showers



- ✓ Calorimeter jets: complex detector behavior
 - ✦ must correct for detector resolution and efficiency
 - ✦ must correct for pile-up interactions (on average 3.6 interactions @ $10^{32}\text{cm}^{-2}\text{s}^{-1}$)



- ✓ Hadron jets:
 - ✦ underlying event subtraction
 - ✦ remove fragmentation/hadronization effects
 - Monte Carlo model based
 - Need to be tuned on data!!!
by using many different observables



- ✓ Parton jets:
 - ✦ Gluon radiation, energy loss
 - Monte Carlo model based

To compare with theory is important to have a good simulation of soft physics: Underlying event, hadronization, fragmentation

- CDF: Underlying Event studies; Jet Shapes (Phys. Rev. D 71, 112002, 2005)
- DO: Dijet azimuthal decorrelations (Phys. Rev. Lett. 94, 221801, 2005)



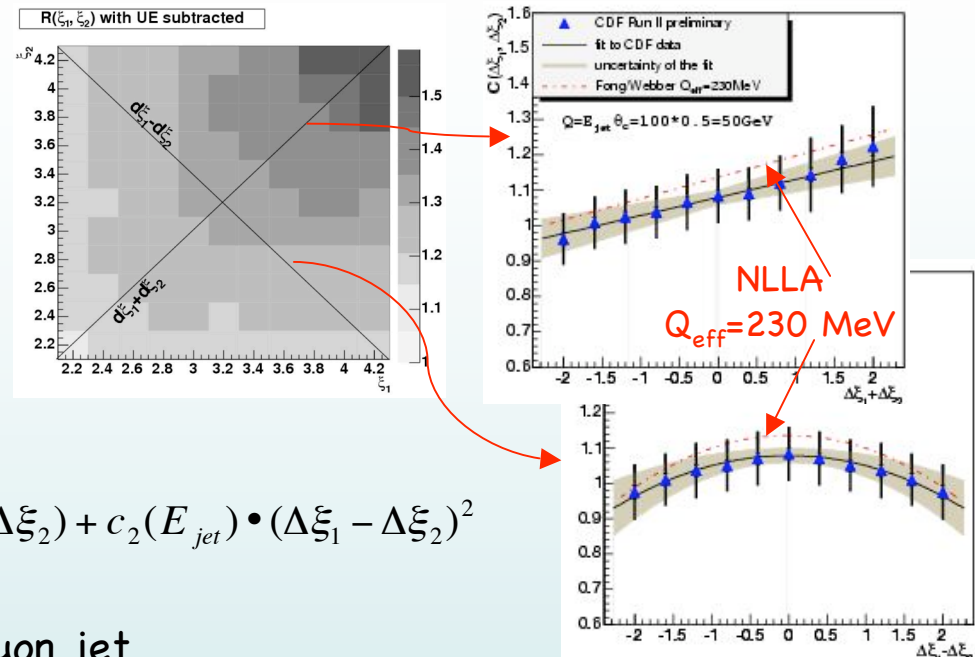
Two particle momentum correlation & hadronization



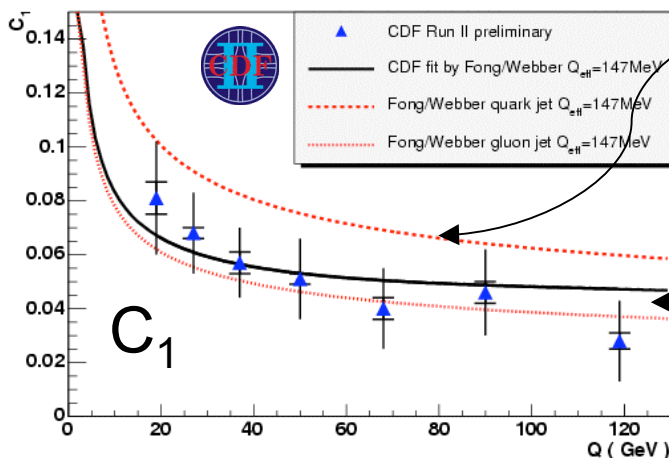
Dijet events $60 \text{ GeV} < M_{jj} < 600 \text{ GeV}$
All particle pairs in cone 0.5 around the jet axis

$\xi = \ln(E_{\text{jet}}/p_{\text{particle}})$, $\Delta\xi = \xi_1 - \xi_2$ at Max

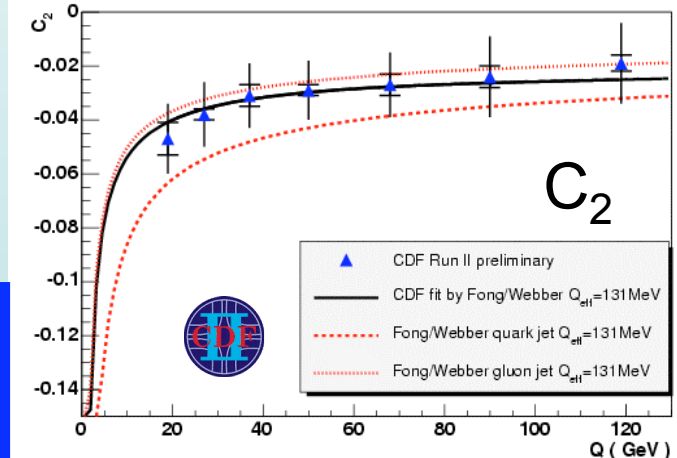
$Q = E_{\text{jet}} \times \theta_{\text{cone}}$; Q_{eff} = parton shower cutoff in the theory



$$C(\xi_1, \xi_2) = \frac{\left(\frac{dn}{d\xi_1 d\xi_2} \right)}{\left(\frac{dn}{d\xi_1} \right) \left(\frac{dn}{d\xi_2} \right)} = c_0(E_{\text{jet}}) + c_1(E_{\text{jet}}) \cdot (\Delta\xi_1 + \Delta\xi_2) + c_2(E_{\text{jet}}) \cdot (\Delta\xi_1 - \Delta\xi_2)^2$$



Local parton-hadron duality: correlation survives hadronization

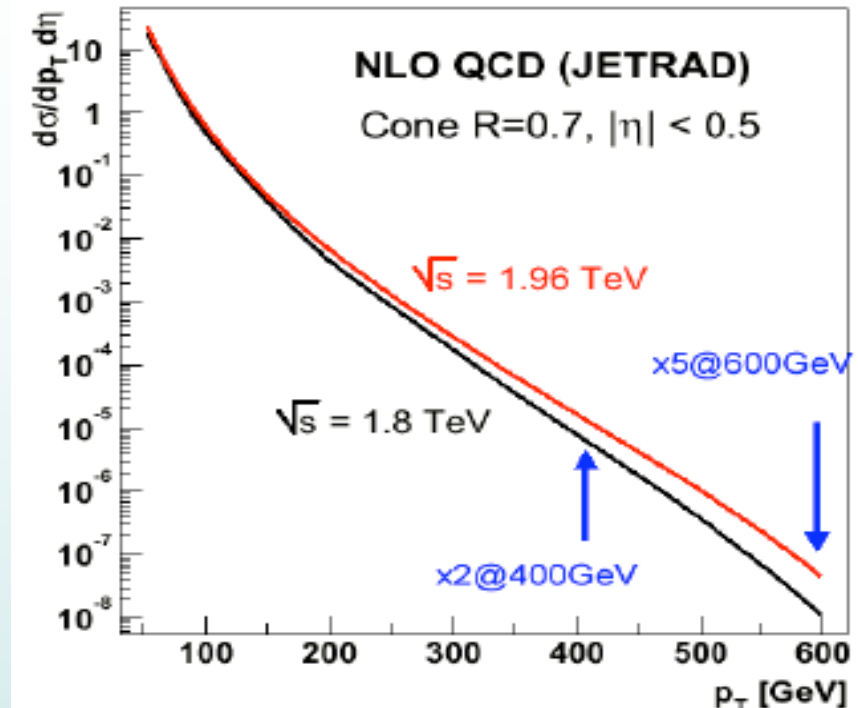
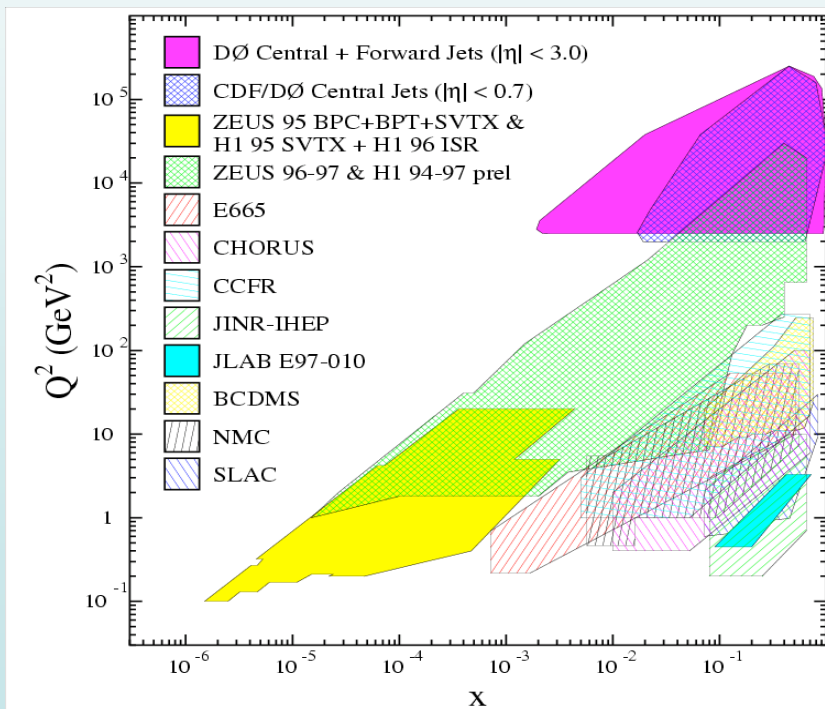




Inclusive Jet Cross Section



- Higher σ with respect to Run I
- Increased p_T range
- Probes physics at small distances $\approx 10^{-19}\text{m}$
- Test pQCD over more than 8 decades in σ
- Sensitive to PDF (gluon @ high- x)

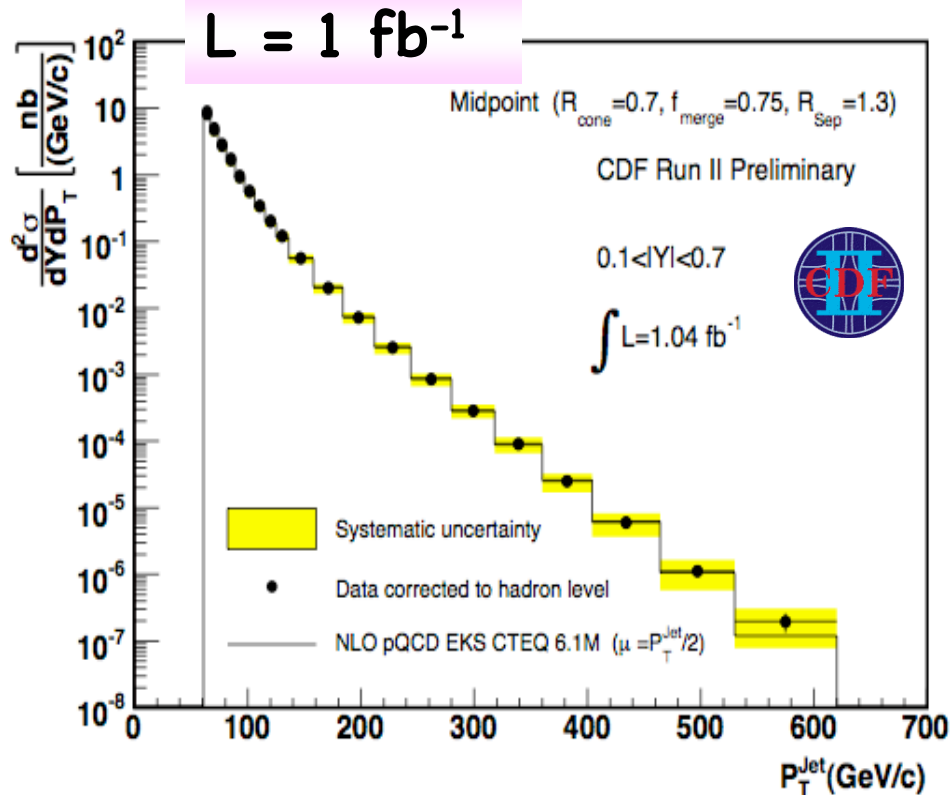


Forward jets measurements:
distinguish between new physics
and PDF if any excess in the
central region.

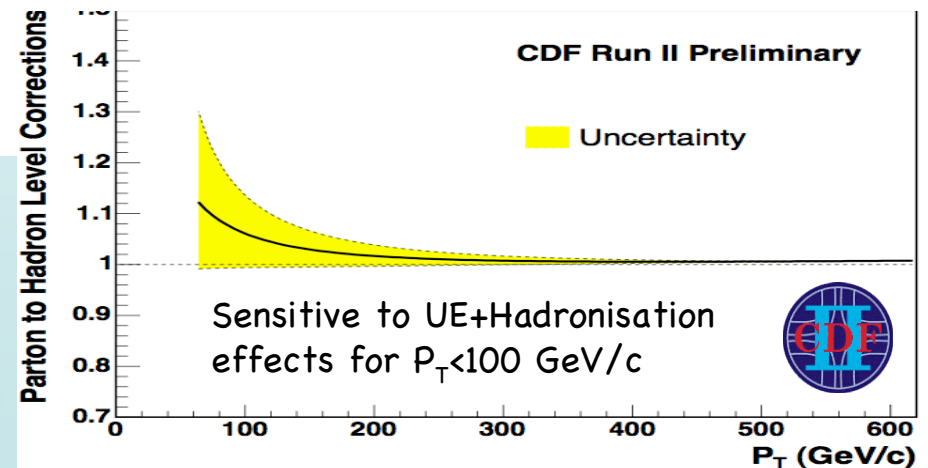
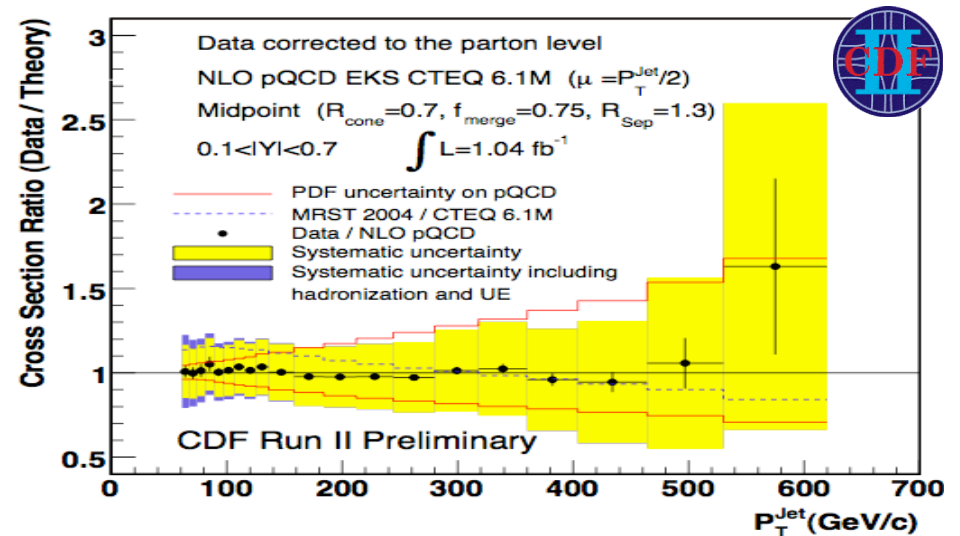


Inclusive Jet Cross Section-CDF

(MidPoint algorithm R=0.7)



Central jets: $0.1 < |y^{\text{jet}}| < 0.7$



- ✓ Systematic dominated by Jet Energy Scale uncertainties (2-3%)
- ✓ NLO uncertainty due to high x gluon PDF

Good agreement with NLO CTEQ6.1M

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XLI Rencontres De Moriond - QCD and high energy
hadronic interactions - La Thuile March 2006



Inclusive Jet Cross Section-D0 (MidPoint algorithm R=0.7)



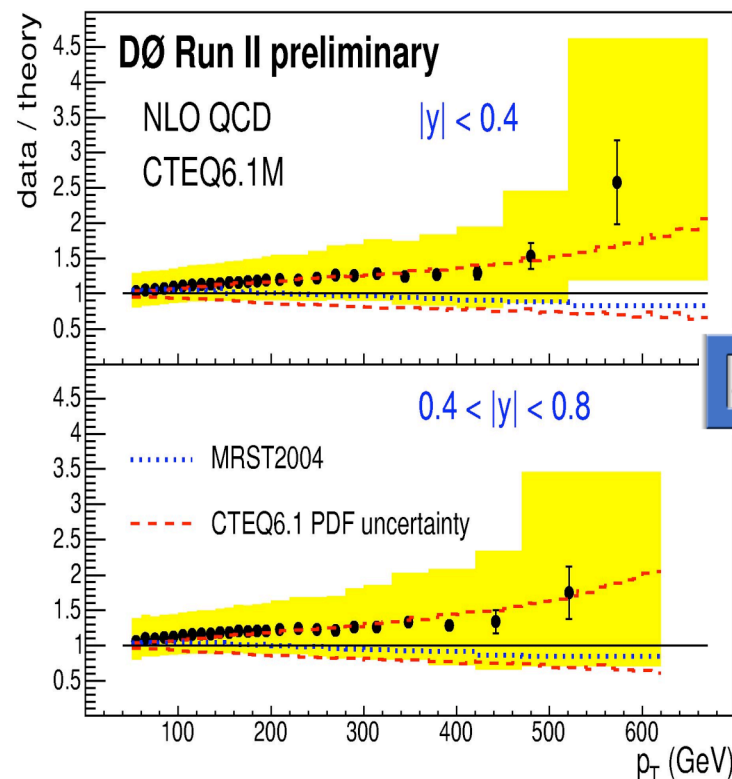
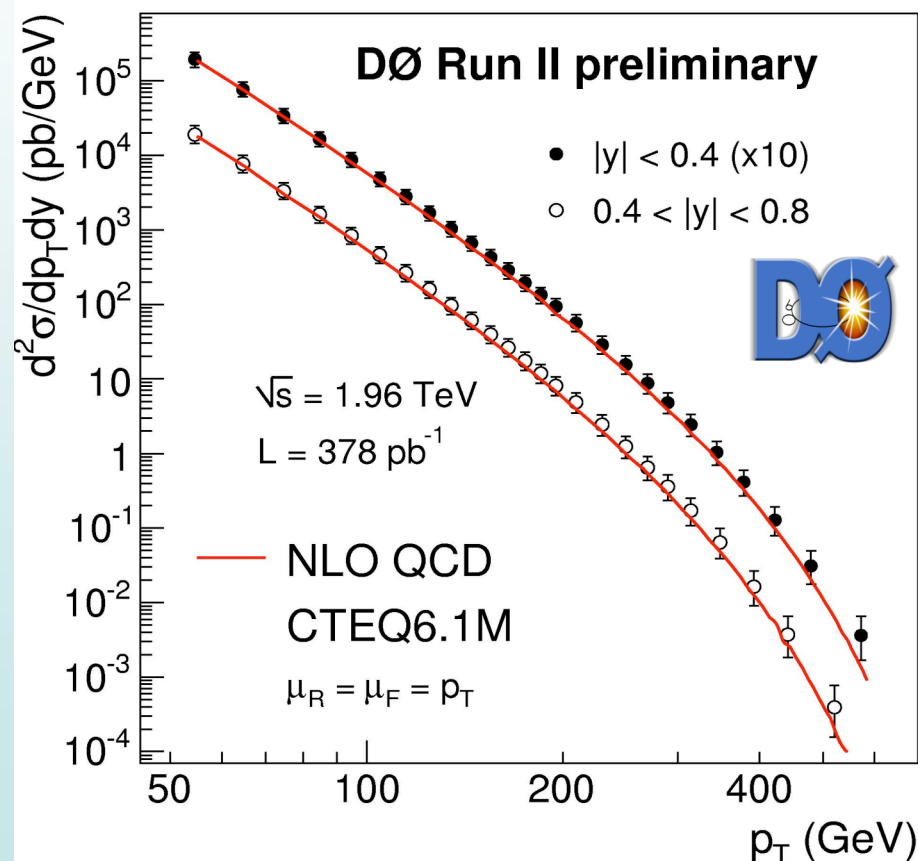
- 2 regions in rapidity explored

$$|y^{\text{jet}}| < 0.4$$

$$0.4 < |y^{\text{jet}}| < 0.8$$

$$L = 380 \text{ pb}^{-1}$$

Jet energy scale uncertainty
→ dominant error



Good agreement with
NLO prediction



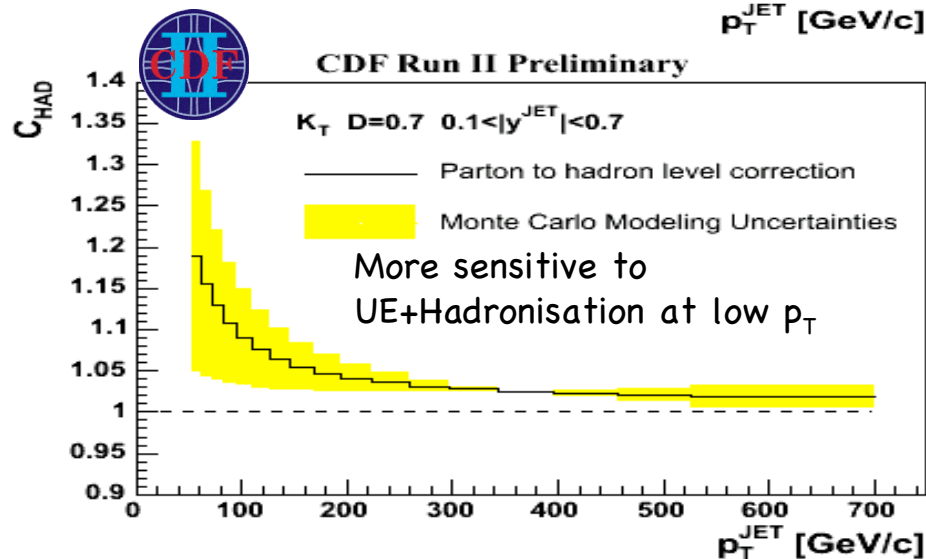
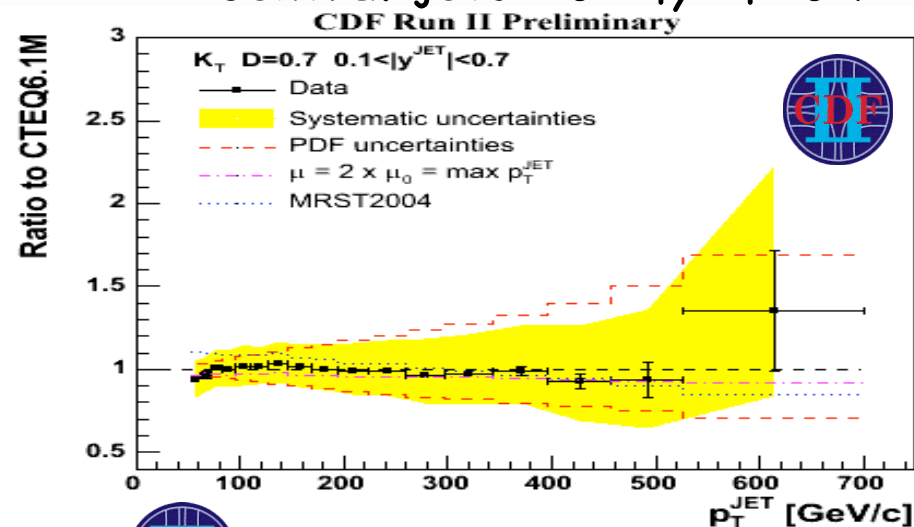
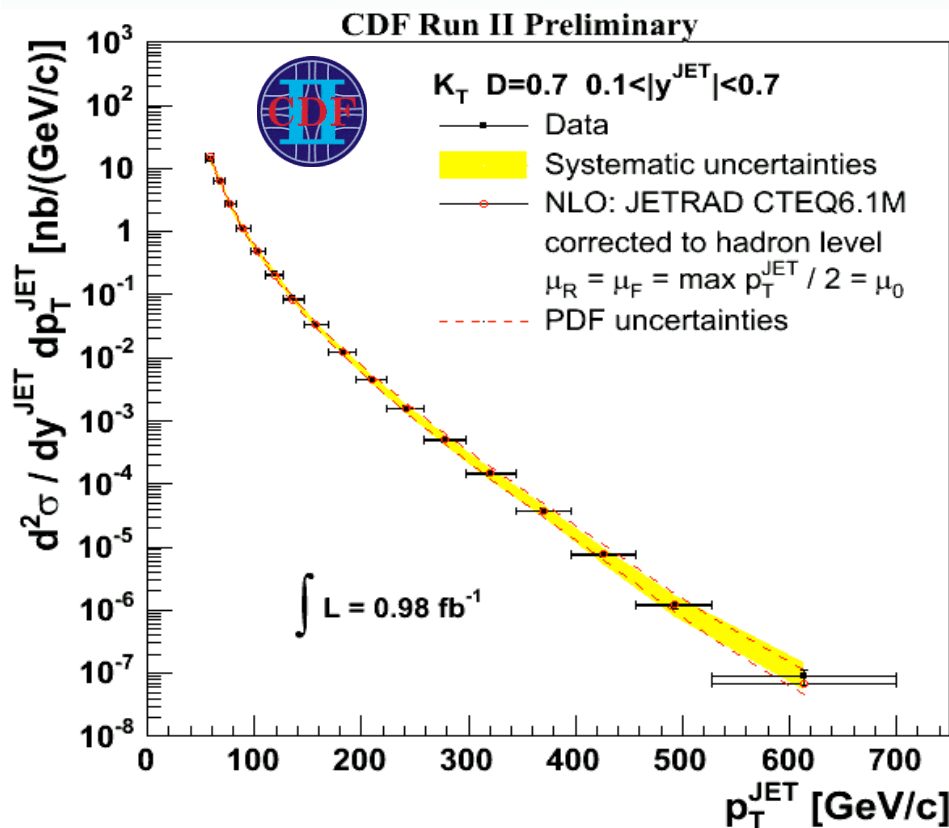
Inclusive Jet Cross Section-CDF



$L = 1 \text{ fb}^{-1}$

(K_T algorithm $D=0.7$)

Central jets: $0.1 < |y^{\text{JET}}| < 0.7$



K_T works well in hadronic collisions

Good agreement with NLO CTEQ6.1M



Forward Jet Cross Section-CDF (K_T algorithm $D=0.7$)

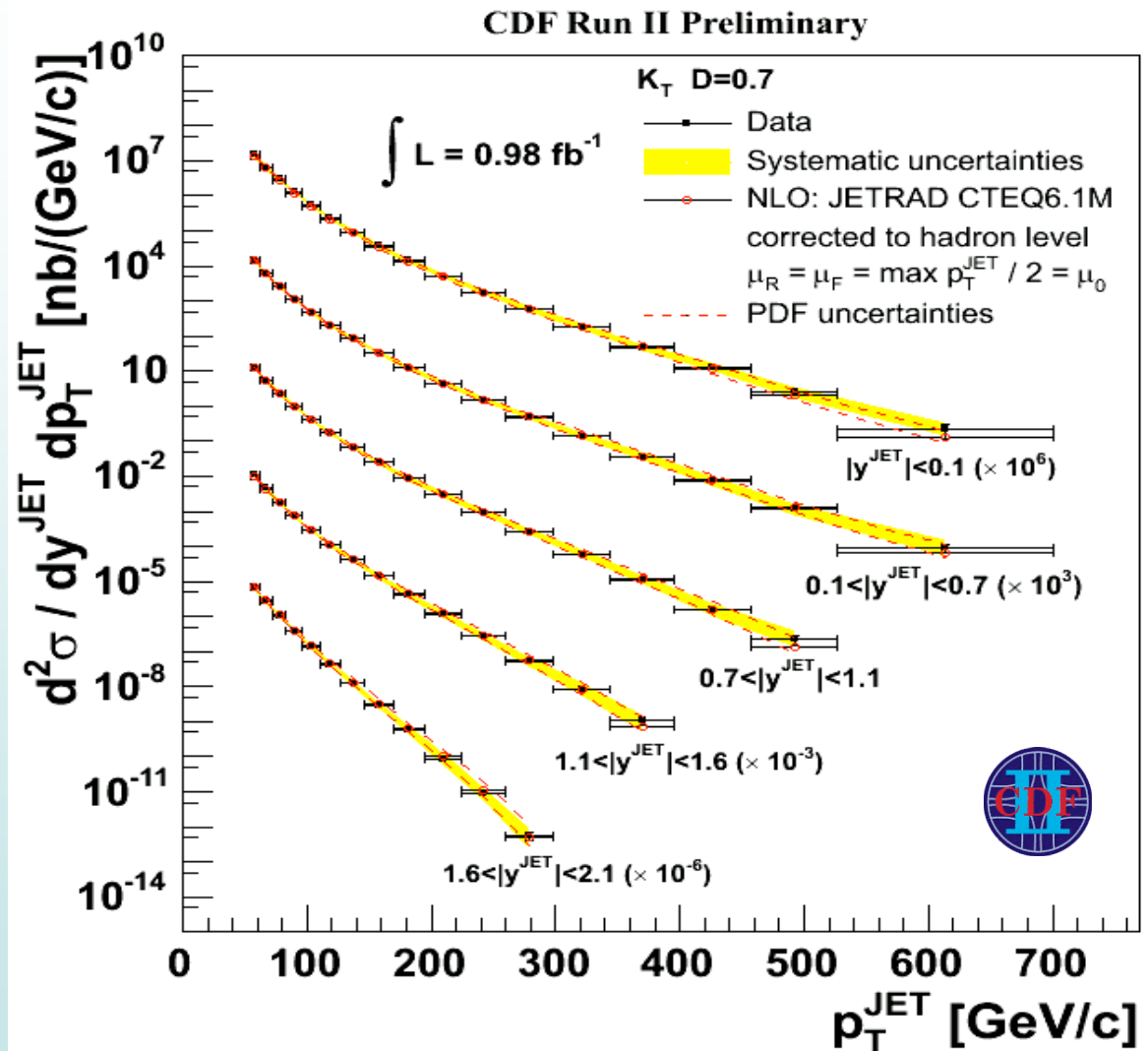


$$L = 1 \text{ fb}^{-1}$$

Five regions in jet rapidity explored ($D=0.7$):

- $|y^{\text{jet}}| < 0.1$
- $0.1 < |y^{\text{jet}}| < 0.7$
- $0.7 < |y^{\text{jet}}| < 1.1$
- $1.1 < |y^{\text{jet}}| < 1.6$
- $1.6 < |y^{\text{jet}}| < 2.1$

Good agreement
with NLO pQCD
for jets up to $|Y| < 2.1$





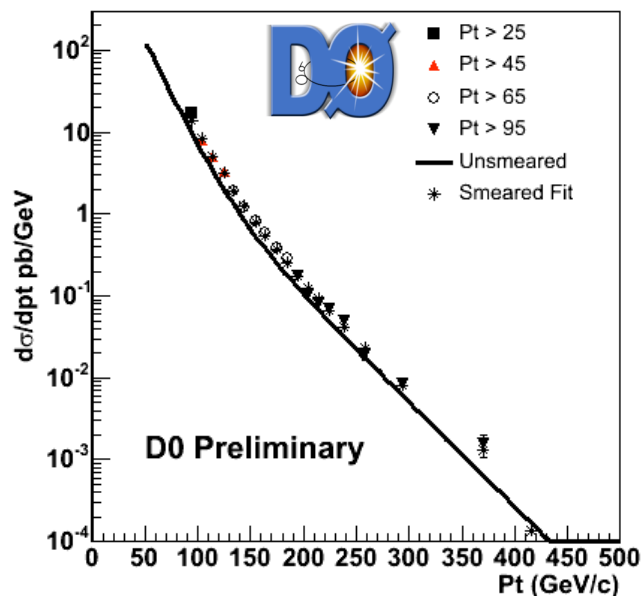
μ -Tagged jets



- jet containing heavy flavour often contain μ
 \Rightarrow search for μ enhances heavy flavour content

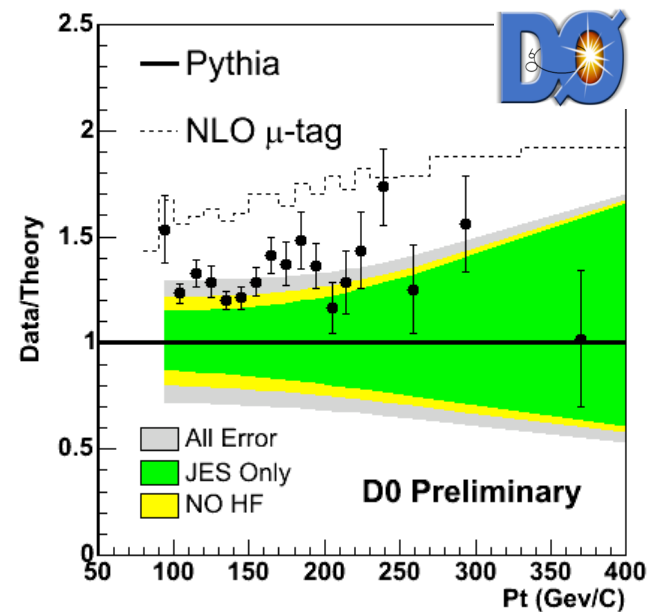
μ -Tagged jets cross section

$L = 300 \text{ pb}^{-1}$



- MidPoint algorithm
cone $R=0.5$
- $|y^{\text{jet}}| < 0.5$
- require μ in $R=0.5$,
 $p_T^{\mu} > 5 \text{ GeV}/c$
- correct for light
flavours

NLO μ -tag = NLO for inclusive jet *
fraction of μ -tag in PYTHIA



$\text{Data/Pythia} \approx 1.3 \text{ (flat)}$



Inclusive bjet cross section

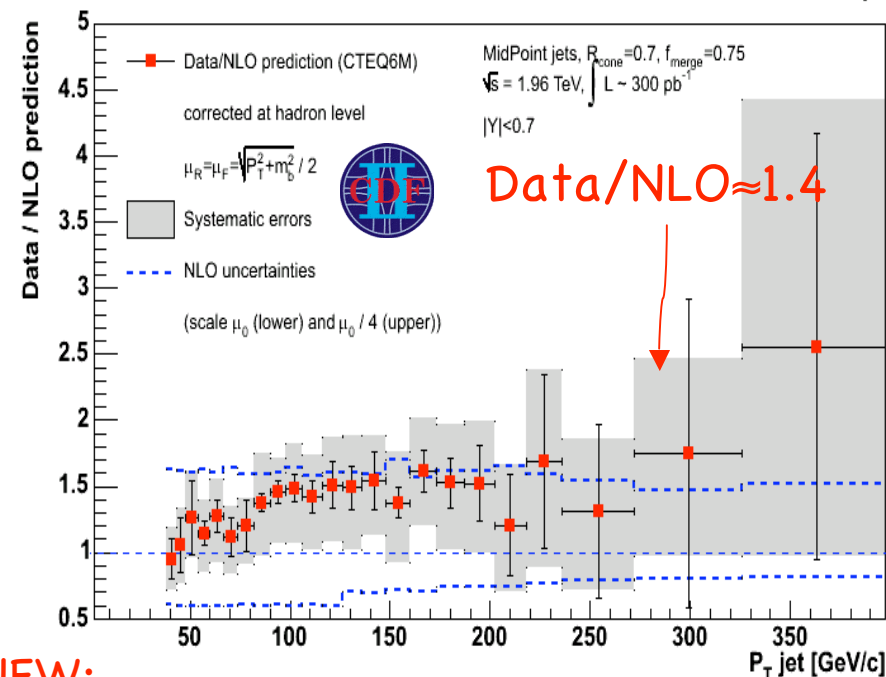
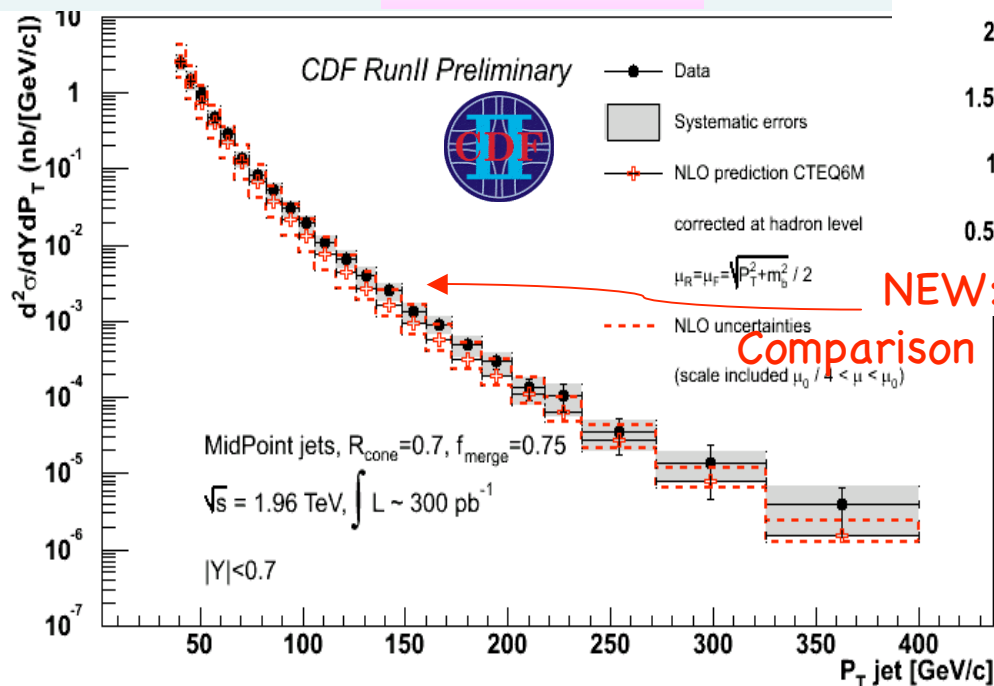


Reconstruct (silicon detector) secondary vertex from B
hadron decays (b-tagging)

CDF RunII Preliminary

- ✓ Beauty production \rightarrow Test of pQCD
- ✓ MidPoint jets: $R = 0.7$, $|\eta^{\text{jet}}| < 0.7$
- ✓ Shape of secondary vertex mass used to extract b-purity from data

$L = 300 \text{ pb}^{-1}$



- ✓ More than 6 decades covered
- ✓ Systematic dominated by Jet Energy Scale and b-purity uncertainties
- ✓ Uncertainties on NLO dominated by μ_R/μ_F scales



Summary



✓ Tevatron delivered More than 1.6 fb^{-1}

‣ Both CDF and D0 are performing well

✓ Rich QCD physics program at Tevatron. Latest results correspond to 1 fb^{-1} data

‣ Good progress in understanding soft p_T physics: underlying event, hadronization and particle correlation

‣ Theory (CTEQ61M) agrees with MidPoint and K_T jet cross section over more than 8 order of magnitude

‣ K_T jet algorithm works fine in hadronic collisions

‣ NLO prediction consistent with b-jet production measurements

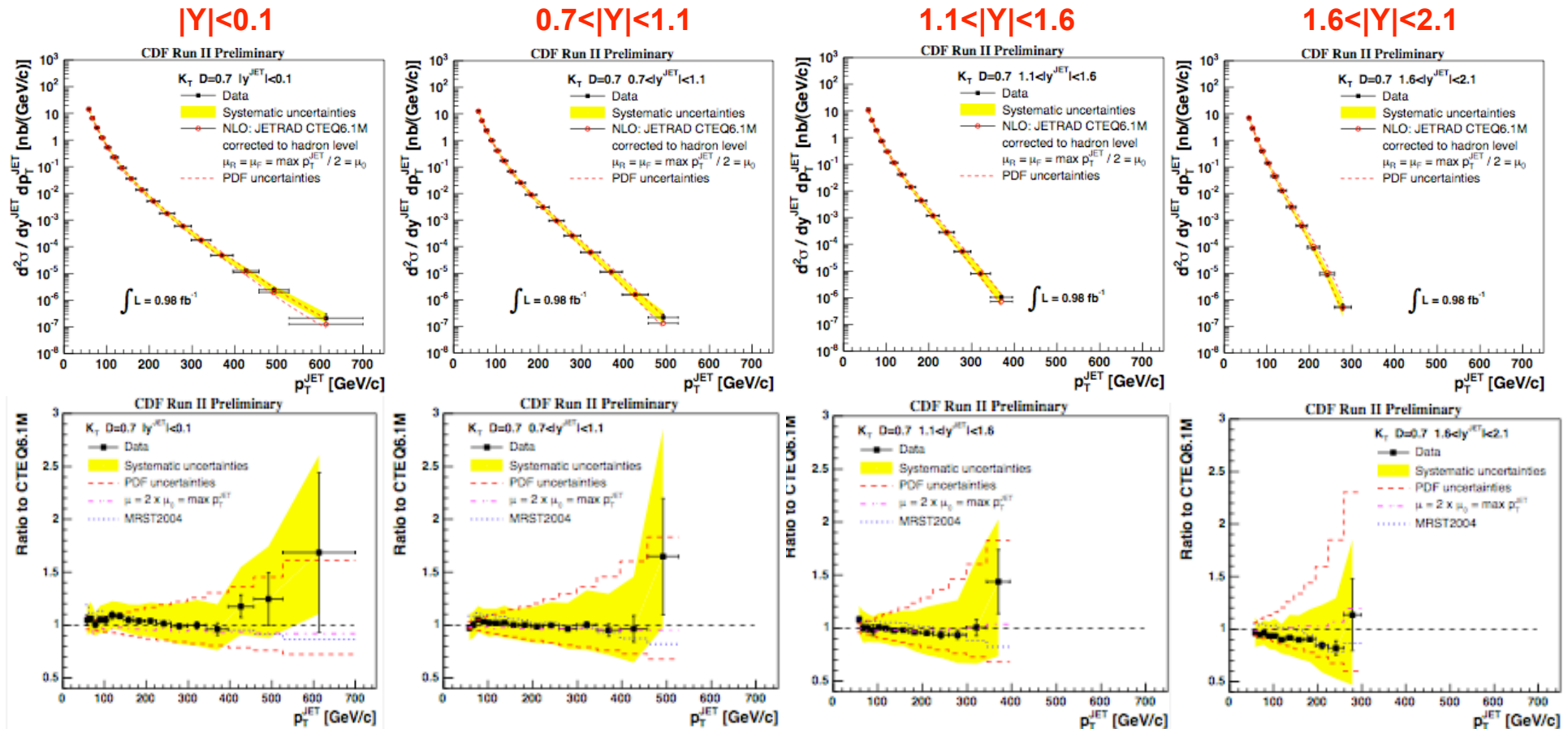


Backup Slides



Inclusive jet K_T

NEW $L = 1 \text{ fb}^{-1}$

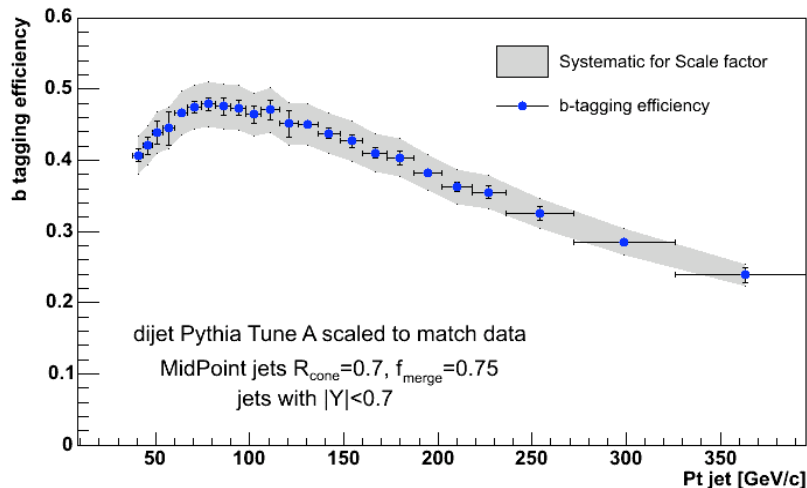


Good agreement with Theory @ NLO!!!

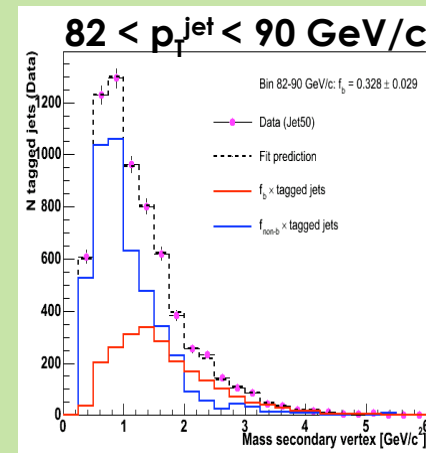
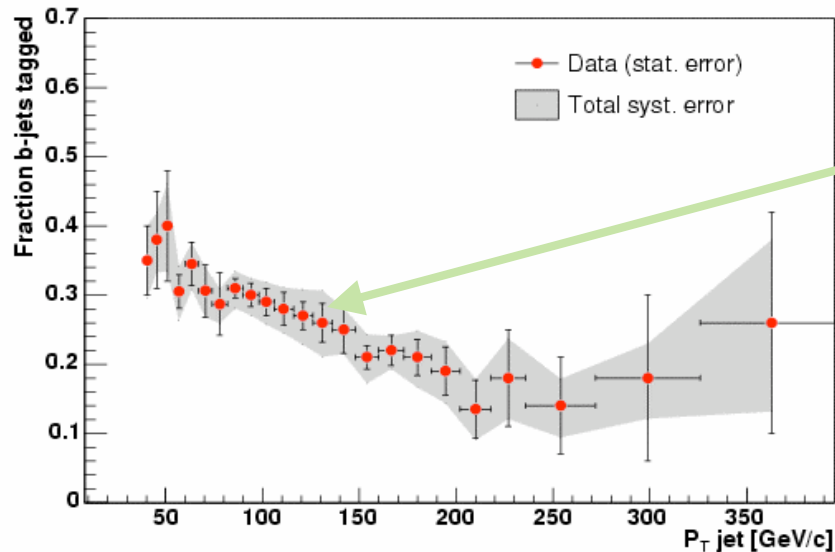
K_T algorithm works in hadron-hadron collisions!!!



High P_T b-jet



Displaced tracks inside jet used to reconstruct secondary vertex from B hadron decays (**b-tagging**)



Extract **fraction** of b-tagged jets from data:

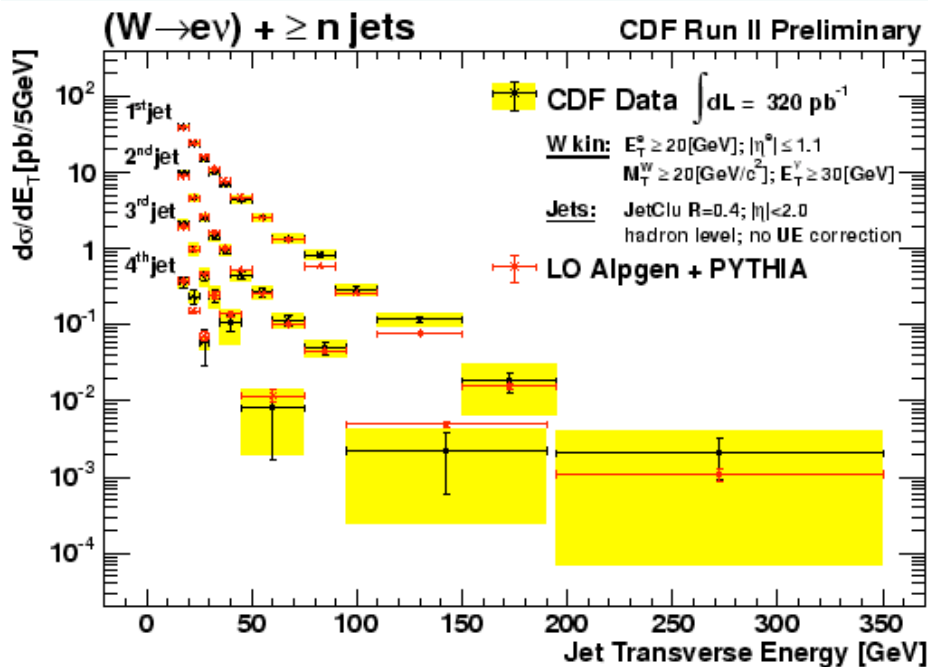
→ use shape of secondary vertex mass



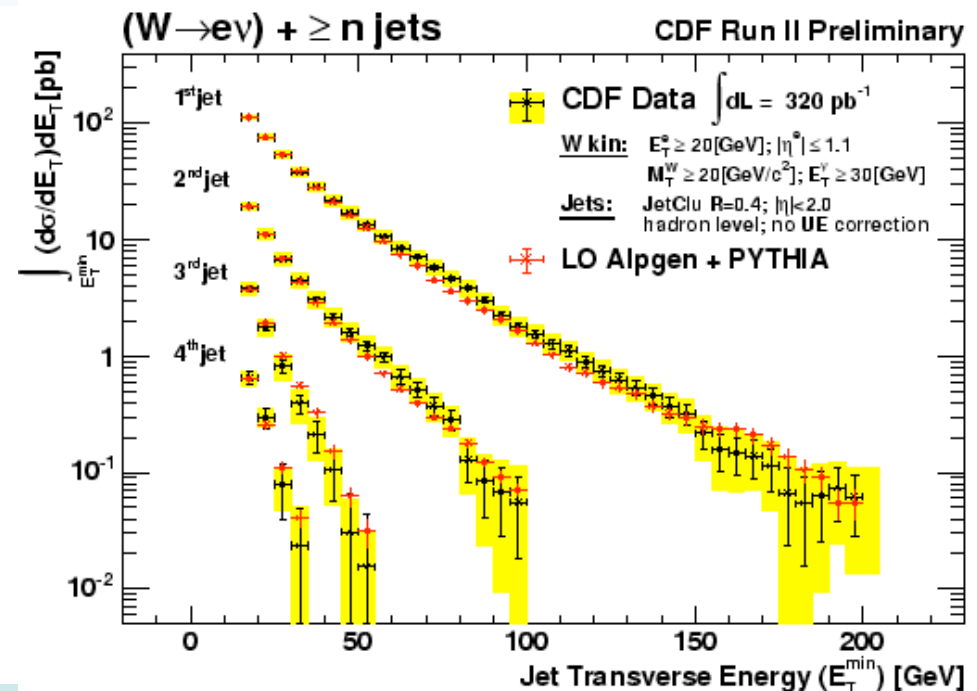
W+jets results



Differential xsec wrt jet E_T in each of the 4 W+ n jet inclusive samples



Integrated xsec wrt jet E_T in each of the 4 W+ n jet inclusive samples



Caveat: this is not a full theory to data comparison. MC have been normalized to data inclusive cross section in each jet multiplicity sample!

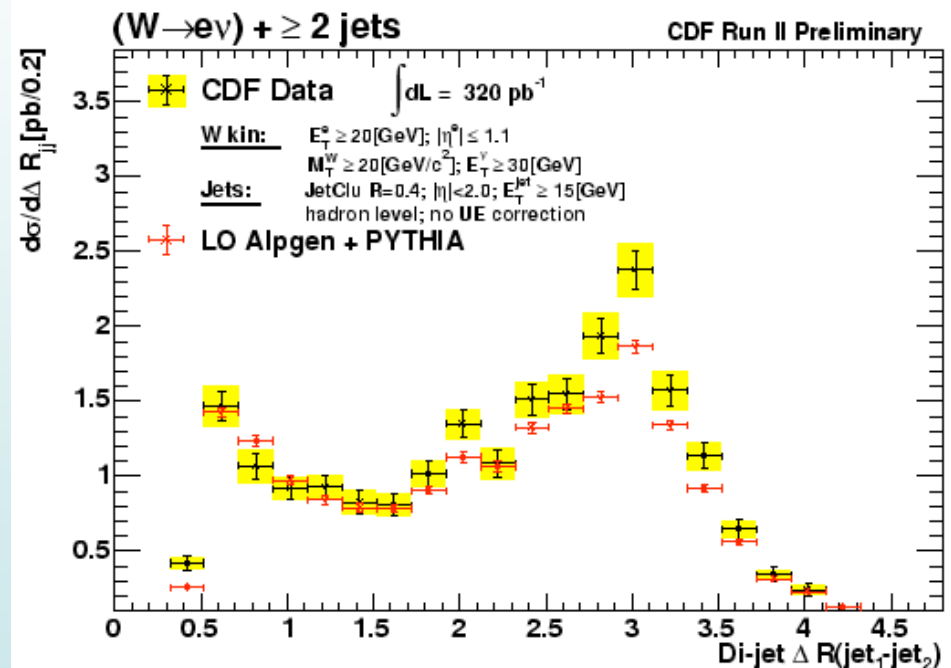
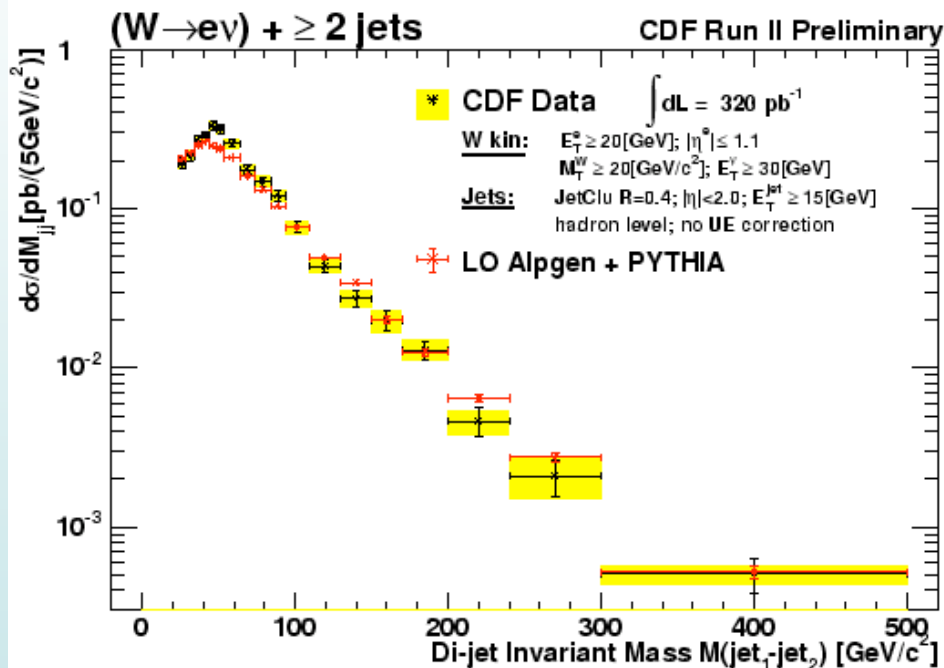


W+jets results



Differential xsec wrt di-jet invariant mass in the W+ 2 jet inclusive samples

Differential xsec wrt di-jet ΔR in the W+ 2 jet inclusive samples



Caveat: this is not a full theory to data comparison. MC have been normalized to data inclusive cross section in each jet multiplicity sample!